

REMARKS/ARGUMENTS

Claims 1-7 are pending in the Application.

Claims 1-7 stand rejected.

Claims 4 and 7 are amended herein.

Claims 8-18 are added herein.

I. OBJECTIONS TO THE SPECIFICATION

The Examiner has objected to the specification due to a number of informalities. Office, Action at 2.

The above-mentioned informalities have been corrected. See "Amendments to the Specification" on page 2 of this paper.

II. REJECTIONS UNDER 35 U.S.C. § 112, ¶ 2

The Examiner has rejected Claim 7 under 35 U.S.C. § 112, ¶ 2, because "the crosslinked carbon nanotube material" is deemed to lack antecedent basis. Office Action, at 2-3.

Claim 7 has been amended to definitively establish such antecedent basis. See "Listing of Claims" which begins on page 3 of this paper.

III. DOUBLE PATENTING REJECTIONS OVER CO-PENDING APPLICATION NO. 10/764,092

The Examiner has provisionally rejected Claims 1-7 under the judicially-created doctrine of obviousness-type double patenting as being unpatentable over claims 1-11 of co-pending Application No. 10/764,092 (the '092 Application). Office Action, at 3-4.

Applicant respectfully traverses this rejection. Applicant notes that, if the "provisional" double patenting rejection is the only rejection remaining in the Application, then the Examiner should withdraw the rejection and permit the Application to issue as a patent. M.P.E.P. §804.

IV. DOUBLE PATENTING REJECTIONS OVER CO-PENDING APPLICATION NO. 10/738,168

The Examiner has provisionally rejected Claims 1-7 under the judicially-created doctrine of obviousness-type double patenting as being unpatentable over Claims 1-28 of co-pending Application No. 10/738,168 (the '168 Application). Office Action, at 4-5.

Applicant respectfully traverses this rejection. Applicant notes that, if the "provisional" double patenting rejection is the only rejection remaining in the Application, then the Examiner should withdraw the rejection and permit the Application to issue as a patent. M.P.E.P. §804.

V. REJECTIONS UNDER 35 U.S.C. § 103(a) OVER *TSAI* IN COMBINATION WITH *BOWER*

Claims 1-7 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Tsai *et al.*, "The Welding of Carbon Nanotubes," *Carbon*, **2000**, 38, 1899-1902 ("*Tsai*") in combination with Bower *et al.*, United States Patent Application Publication No. 2002/0114949 ("*Bower*"). Office Action, at 5.

The Examiner contends that "Tsai teaches a method comprising a step of irradiating carbon nanotubes with microwaves (= carbon nanotubes were grown onto a silicon layer using a microwave plasma enhanced chemical vapor deposition (MPE-CVD)) [pages 1900-1901; and Fig. 3]." Office Action, at 5.

Applicant respectfully points out that while *Tsai* does teach MPE-CVD growth of carbon nanotubes, *Tsai* does not teach the direct irradiation of the carbon nanotubes with microwaves. Rather, *Tsai* is merely using the microwave radiation to form a plasma from CH₄ and H₂ so as to provide carbon atoms for nanotube growth. See *Tsai*, page 1901, col. 1, ll. 6-10.

Claim 1

Claim 1 requires irradiating carbon nanotubes with microwaves to yield a plurality of crosslinked carbon nanotubes.

Regarding Claim 1, the Examiner contends that, while *Tsai* does not disclose "[t]o yield a plurality of crosslinked carbon nanotubes," *Tsai* does teach that "joining nanotubes grow steadily and then the Pd or Pd-Si alloy nanoparticles would sink into the carbon nanotube and lengthen it into the Pd or Pd-Si alloy nanowires," and that "[t]he welding of nanotubes into Y-junction onto a silicon wafer can be effectively achieved by MPE-CVD with a CH₄/H₂ gas mixture (page 1901; and Fig. 3)." The Examiner further contends that "[t]he invention as a whole would have been obvious to one having ordinary skill in the art at the time the invention was made because the growing of the joined nanotubes and/or welding of the nanotubes into a Y-junction by MPE-CVD are deemed to inherently yield a plurality of crosslinked carbon nanotubes because similar processes can reasonably be expected to yield products which inherently have the same properties." Office Action, at 5-6.

As mentioned previously, *Tsai* does not teach or suggest irradiating the carbon nanotubes with microwaves. Rather, microwaves are used in *Tsai* to generate a plasma from CH₄/H₂ so as to provide carbon atoms for nanotube growth. Moreover, the "welding" of *Tsai* is really a misnomer, as the Y-junction is grown, not fused (or crosslinked) together. Most importantly, even if *Tsai* were to directly irradiate the carbon nanotubes with microwave radiation, the inter-tube separation, being on the order of tens of nanometers and as depicted in Figs. 2 and 3 of *Tsai*, preclude the formation of covalent bonds *between* the carbon nanotubes (as required for crosslinking). As *Tsai* neither teaches nor suggests irradiating carbon nanotubes with microwaves, and as the nanotubes of *Tsai* are not spatially amenable to crosslinking, Claim 1 is not obvious in view of, and hence not unpatentable over, *Tsai*. See M.P.E.P. 706.02(j); see also *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

Claim 2

Claim 2, depending from Claim 1, further requires that the step of irradiating be carried out in an inert environment selected from the group consisting of ultra-high vacuum, high

vacuum, inert gases, and combinations thereof.

Regarding Claim 2, the Examiner contends that, like *Tsai*, "Bower teaches growing carbon nanotubes by MPECVD," and "that a MPECVD system contains a vacuum chamber **10** equipped with a microwave source **11** and a heater **12**." The Examiner further contends that "[i]t would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by *Tsai* with wherein the step of irradiating is carried out in an inert environment selected from the group consisting of ultra-high vacuum, high vacuum, inert gases, and combinations thereof because a MPECVD contains a vacuum chamber as taught by Bower," and that "one having ordinary skill in the art, without undue experimentation, would have readily determined a 'high' vacuum." Office Action, at 6-7.

Applicant respectfully points out that, as in the case of *Tsai*, *Bower* does not teach irradiating carbon nanotubes with microwaves. That *Bower* carries out their MPECVD growth of carbon nanotubes in vacuum is irrelevant because Claim 2, as dependent on Claim 1, still requires the irradiation of carbon nanotubes and their crosslinking—neither of which are taught nor suggested by either of *Tsai* or *Bower*. Moreover, the spatial positioning of the nanotubes in *Tsai* and *Bower* preclude the formation of covalent bonds between them—as required for crosslinking. Accordingly Claim 2 is not obvious in view of the combination of *Tsai* and *Bower*.

Claims 3 and 4

Claim 3 depends from Claim 1 and further requires that the microwave radiation comprises a frequency that ranges from about 0.01 GHz to about 100 GHz.

Claim 4 depends from Claim 3 and further requires that the frequency ranges from about 1 GHz to about 18 GHz.

Regarding Claims 3 and 4, the Examiner contends that because *Bower* teaches a MPECVD system comprising a microwave source where "[t]ypical microwave frequencies are 2.45 GHz and 915 MHz," that "[i]t would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method by *Tsai* with wherein the microwave radiation comprises a frequency that ranges from about 0.01 GHz to about 100 GHz

and wherein the frequency ranges from about 1 GHz to about 18 GHz because the typical microwave energy frequencies are 2.45 GHz and 915 MHz as taught by Bower." Office Action, at 7.

Applicant respectfully points out that Claims 3 and 4 depend directly and indirectly, respectfully, from Claim 1 and are not obvious in view of the combination of *Tsai* and *Bower* for the same reasons Claim 1 is not obvious in view of *Tsai* and *Bower*: *Tsai* and *Bower* neither teach nor suggest the irradiation of carbon nanotubes with microwave radiation, and that the spatial positioning of the nanotubes grown by *Tsai* and *Bower* preclude their crosslinking (see above). That *Bower* uses microwaves of similar frequencies to generate a plasma used to grow nanotubes is irrelevant. Accordingly, neither Claim 3 nor Claim 4 is obvious in view of the combination of *Tsai* and *Bower*.

Claims 5 and 6

Claim 5 depends from Claim 1 and further requires that the microwave radiation is generated by a magnetron with a power that ranges from about 1 W to about 10,000 W.

Claim 6 depends from Claim 5, further requiring that the power ranges from about 10 W to about 1,000 W.

Regarding Claims 5 and 6, the Examiner contends that typical plasma parameters, as taught by *Bower*, "include a microwave power input of 1-5 kW and a gas pressure of 10-100 Torr," and that "[i]t would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by *Tsai* with wherein the microwave radiation is generated by a magnetron with a power that ranges from about 1 W to about 10,000 W and wherein the power ranges from about 10 W to about 1,000 W because the typical plasma parameters include a microwave power input of 1-5 kW." Office Action, at 7-8.

Applicant respectfully points out that Claims 5 and 6 depend directly or indirectly from Claim 1 and are not obvious in view of the combination of *Tsai* and *Bower* for the same reasons that Claim 1 is not obvious in view of the combination of *Tsai* and *Bower*. Applicant acknowledges that a magnetron is a common source of microwaves, but *Tsai* and *Bower* use such

microwaves to generate a plasma for inducing growth of nanotubes—not their crosslinking by irradiation. Accordingly, Claims 5 and 6 are not obvious in view of *Tsai* combined with *Bower*.

Claim 7

Claim 7, as amended (see above) and depending from Claim 1, further requires that the plurality of crosslinked nanotubes comprises at least one junction formed via a rearrangement of carbon atoms.

Regarding Claim 7, the Examiner contends that "Tsai teaches that joining nanotubes grow steadily and then the Pd or Pd-Si alloy nanoparticles would sink into the carbon nanotube and lengthen it into the Pd or Pd-Si alloy nanowires," that "[t]he welding of nanotubes into Y-junction onto a silicon wafer can be effectively achieved by MPE-CVD with a CH₄/H₂ gas mixture," and that "[t]he invention as a whole would have been obvious to one having ordinary skill in the art at the time the invention was made because the growing of the joined nanotubes and/or the welding of the nanotubes into a Y-junction by MPE-CVD are deemed to inherently crosslink the carbon nanotube material to comprise at least one junction formed via the rearrangement of carbon atoms because similar processes can reasonably be expected to yield products which inherently have the same properties." Office Action, at 8-9.

Claim 7, as dependent from Claim 1, is not obvious in view of *Tsai* for the same reasons Claim 1 is not obvious in view of *Tsai*. Additionally, Applicant respectfully points out that the Y-junction of *Tsai* is formed via the *assembly* of carbon atoms, not their *rearrangement* via microwave-induced crosslinking—as required by amended Claim 7. Accordingly, Claim 7, as amended, is not obvious in view of *Tsai*.

As a result of the foregoing, Applicant respectfully requests that the Examiner withdraw the rejection of Claims 1-7 under 35 U.S.C. § 103(a) as being obvious over *Tsai* in combination with *Bower*.

VI. ADDED CLAIMS

Claims 8-18 are added herein. Support for such claims can be found in the Application on page 8, para. [0028]. No new matter is introduced as a result of this addition of claims.

VII. CONCLUSION

As a result of the foregoing, it is asserted by Applicant that the Claims in the Application are now in a condition for allowance, and respectfully request allowance of such Claims. Applicant further respectfully requests that the Examiner call Applicant's attorney/agent at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

Respectfully submitted,

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PATENT

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8

I hereby certify that the attached *AMENDMENT UNDER 37 CFR § 1.111* is being deposited with the USPS with sufficient postage, as first class mail, addressed to Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this the 16th day of February, 2006.

2/16/06
Date

J. E. Huan
Signature

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